

REMARKS

Claims 1-35 are pending. Claims 2-6, 8, 25 and 30 stand objected to as being dependent on rejected base claims. Claims 10-18 are allowed. Claims 1, 7, 9, 19-24, 26-29 and 31-34 are rejected. Claim 35 has been added herein. Support for the new claim is based on original claim 1.

Applicants' Response to Claim Rejections under 35 U.S.C. § 102(e)

Claims 1 and 9 stand rejected under 35 U.S.C. 102(e) as being anticipated by Heo, et al. (US 2004/0171271A1). Applicants respectfully traverse on the basis that claim 1 is not anticipated within the meaning of §102, because each and every limitation is not taught in the cited reference. Specifically, the limitation that the silicon nitride layer has a thickness of 20 nm or thicker is not present in Heo et al. Heo et al. teaches the use of a thinner silicon nitride layer to minimize the effect of the nitride layer with respect to the aspect ratio of a narrower trench.

The Office Action asserts that Heo et al. discloses a silicon nitride layer of 20 nm or greater, referencing paragraph [0035]. However, applicants respectfully submit that there is no such disclosure in the paragraph. Rather, Heo et al. teaches a lower thickness for the silicon nitride layer 150. Heo et al. states in paragraph [0035] that "... the nitride liner 150 is ... formed to a thickness ...about 30 to 140 Å." Since 1 nm=10Å, the cited thickness is from about 3 to 14 nm, smaller than 20 nm. This thickness is taught to prevent diffusion of impurities while also minimizing the effect of the silicon nitride layer with respect the aspect ratio of the first trench 131 (i.e. narrower trenches).

Applicants further submit that the claimed limitation would not be inherent or obvious in light of the disclosures of Heo et al. Specifically, as set forth above, Heo et al. teaches away

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from utilizing a silicon nitride layer greater than 14 nm. A greater thickness is taught as possibly disrupting the formation of the isolation region in the first trench 131. See paragraph [0035].

However, the present invention teaches toward a greater thickness to obtain a process free of tear-off by utilizing the silicon nitride layer in the trench. Specifically, the influence of the thickness of the silicon nitride liner layer was studied by the present inventors. Their research indicates that no tear-off occurs if the thickness of the silicon nitride liner layer is set to 20 nm or thicker. See page 11, lines 8-11. There is no such disclosure in Heo et al. and Heo et al. teaches toward a thinner silicon nitride layer. Applicants respectfully submit that the rejection of claim 9 is likewise addressed by nature of the claims dependency to claim 1. Applicants, in light of the above remarks, respectfully request favorable reconsideration.

Applicants' Response to Claims Rejections under 35 U.S.C. § 103(a)

Claims 7, 19-24, 26-29 and 31-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heo et al. as applied to claim 1 and further in view of Laxman, et al. (US 5,874,368). In regard to claim 7, the rejection is traversed as above by nature of the claim's dependency to claim 1. Further, Applicant's claim 7 recites an annealing step at 1000°C to 1150°C, after depositing silicon nitride liner. The Office Action points to Laxman as disclosing this limitation. However, Laxman recites a deposition temperature including 1000°C at the highest, not an anneal step at 1000°C to 1150°C, after deposition. See Column 2, lines 37-38.

In regard to independent claims 19, 24, and 29, they require carbon present in the silicon nitride liner as a limitation. The Office Action has added Laxman et al. for its apparent teaching of a silicon nitride which contains carbon. The Office Action maintains that because organic source material is used, carbon will be incorporated into the nitride layer.

Applicants respectfully submit that Laxman et al. is teaching away from a silicon nitride which has a carbon contaminant. Laxman specifically states that “analogous aminosilanes... do not deposit carbon free films at such low temperatures.” See Col. 4, lines 19-23. See also column 4, lines 23-36 (the claimed silane forms stable leaving groups which do not cause contamination). The third listed advantage of Laxman et al. at column 4, lines 45-47 states:

- 3) The precursor does not contain direct Si – C bonds, and
the resulting silicon nitride films were carbon free, as
indicated by auger spectroscopy.

The Office Action cites to Table 1 which discloses a number of precursor materials as comparative examples to the taught invention. The comparative examples are considered inferior by Laxman et al. because they result in carbon contamination.

In short, one skilled in the art reviewing Laxman et al. would not be motivated to combine the comparative examples with the teachings of Heo et al. Laxman et al. clearly teaches away from carbon contamination. The actual invention of Laxman et al. combined with Heo et al. would not result in the present invention of claims 19, 24, and 29 because these claims require carbon in the silicon nitride layer.

In other words, the teachings of Laxman are directly contrary to the teachings of the present application. According to the applicant’s invention, the carbon-containing silicon nitride film has the following merits: (1) there are less charge trap sites so that the film is hardly charged; (2) the carbon-containing silicon nitride has good adhesion to the underlying silicon oxide film, and peel-off can hardly occur; (3) tensile stress of the silicon nitride is increased to increase the transistor characteristics; and (4) it has strong resistance against boiling phosphoric acid, and there is less possibility of causing divot. These merits are confirmed in comparison

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with the carbon-free silicon nitride film. Hence, applicants respectfully submit that the present invention of claims 19, 24 and 29 and there respective dependent claims would not be obvious over Heo et al. as applied to claim 1 and further in view of Laxman, et al. (US 5,874,368). Laxman et al. does not teach a carbon-containing silicon nitride film as required by applicants' claims, but in fact teaches away from it. Wherefore, favorable reconsideration is respectfully requested.

In view of the aforementioned amendments and accompanying remarks, Applicants submit that that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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